MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

EEL3036 – POWER SYSTEMS ANALYSIS

(LE)

20 OCTOBER 2018
2.30 p.m – 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 pages including the cover page with 4 Questions only.

2. Answer **ALL** questions. The distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) American National Standard Institute (ANSI) and Institute of Electrical and Electronics Engineers (IEEE) have published a set of standard symbols for electrical diagrams. Draw the standard symbols for the following:

(i) Power circuit breaker (oil or liquid)
(ii) Power circuit breaker (air)
(iii) Three-phase wye, neutral ungrounded
(iv) Three winding power transformer

[4 marks]

(b) A single line diagram of a power system is shown in Fig. Q1(b). The ratings of various components and the reactance of the transmission line are also shown in the figure. Select a common base of 70 MVA, 220 kV in transmission line. Draw an impedance diagram with all the values properly placed in the drawing. [16 marks]

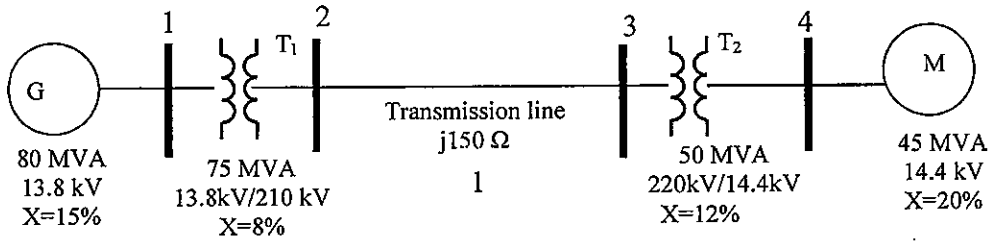

Fig. Q1(b)

(c) A single line diagram of a power system is shown in Fig. Q1(c). The ratings of various components and the reactance of the transmission line are listed below. Choose a base of 60 MVA and base kV as 13.8 kV from Section A. Obtain the new per unit impedance values for G_1 and Line 1. [5 marks]

Data for the system is:
G_1: 50 MVA, 13.8 kV, X=0.15 p.u
G_2: 20 MVA, 14.4 kV, X=0.15 p.u
M : 20 MVA, 14.4 kV, X=0.15 p.u
T_1 : 60 MVA, 13.2kV/165kV, X=0.10 p.u
T_2 : 25 MVA, 13.1kV/160kV, X=0.10 p.u
T_3 : 25 MVA, 13.2kV/155kV, X=0.10 p.u

Line 1: 20+j80 Ω
Line 2: 10+j40 Ω
Line 3: 10+j40 Ω
Load: 20+j15 MVA at 12.63 kV

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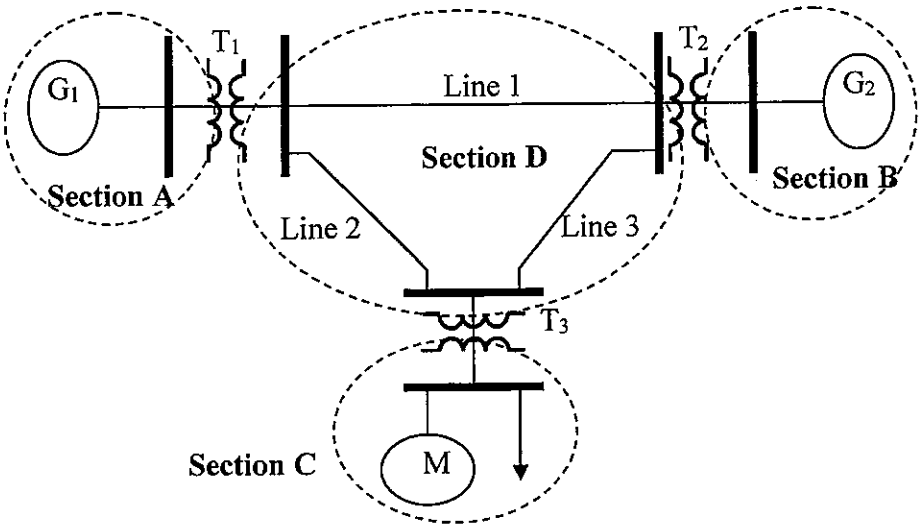

Fig. Q1(c)

Question 2

The bus admittance matrix and the bus data corresponding to a 4-bus network are given below.

$$Y_{bus} = \begin{bmatrix} -j25 & j15 & 0 & j10 \\ j15 & -j40 & j25 & 0 \\ 0 & j25 & -j40 & 0 \\ j10 & 0 & 0 & -j10 \end{bmatrix}$$

Bus No	Generation		Load			
	P, per unit	Q, per unit	P, per unit	Q, per unit	V, per unit	Remarks
1	-	-	0	0	$1.05\angle 0^0$	Slack Bus
2	8	4	1	1	$1.00\angle 0^0$	Load Bus
3	5	-	0.50	0.1	$1.04\angle 0^0$	PV Bus
4	5	-	0.50	0.1	$1.04\angle 0^0$	PV Bus

(a) Determine the voltage at bus 2 at the end of the first iteration of the Gauss-Seidel method of power-flow analysis. [5 marks]

(b) Using the Newton Raphson method, obtain the initial values of the second row, first column Jacobian element. [5 marks]

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(c) Using Decoupled Newton Raphson method, assuming that all the angle corrections $\Delta\delta_2$, $\Delta\delta_3$ and $\Delta\delta_4$ are zero degree, calculate the following:

(i) The reactive mismatches; $\frac{\Delta Q_2}{|V_2|}$ [7 marks]

(Hint: You need to solve for $Q_{2,scheduled}$ and $Q_{2,calculated}$)

(ii) Matrix $\overline{B}$ [3 marks]

(iii) The voltage magnitude at Bus 2, at the end of first-iteration, $V_2^{(1)}$ [5 marks]

Question 3

A 100 MVA, 13.8 kV, Y-connected synchronous generator has a sub-transient reactance of 0.25 per unit., a negative-sequence reactance of 0.25 per unit, a zero-sequence reactance of 0.2 per unit, and a negligible resistance. The neutral of the generator is solidly grounded. Assume that the generator is initially unloaded and operating at rated voltage, 1 per unit. Calculate the phase currents I_A, I_B and I_C for the following faults:

(a) A single line-to-ground fault occurs on phase '***a***' at the terminals of the generator. [13 marks]

(b) A line-to-line fault on an unloaded Y-connected generator with its neutral grounded through a reactance, with the fault on phases '***b***' and '***c***'. [12 marks]

Question 4

(a) The short transmission line of Fig. Q4 is subjected to a three-phase fault at point P. The machine is delivering 1.0 per unit. power and both the terminal voltage and inifinite bus voltage are 1.0 per unit. The reactances of the transmission lines is 0.4 p.u. and the reactance of the transformer is 0.1 per unit. The transient reactance of the generator is 0.3 per unit and $H = 5$ MJ/MVA. Assume the system frequency is 60 Hz. Obtain the following:

(i) Power angle equation [11 marks]

(ii) Power angle curve [3 marks]

(iii) Critical clearing time, t_{cr}, when the critical clearing angle, δ_{cr} is given as 82.5°. [2 marks]

(Hint: $t_{cr} = \sqrt{\frac{4H(\delta_{cr} - \delta_0)}{\omega_s P_m}}$)

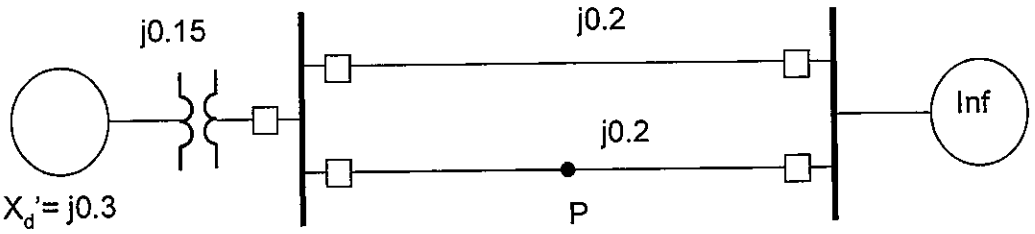

Fig. Q4

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(b) A generator is supplying 1.0 per unit. of power to an infinite bus through a reactive network. A fault occurs and is cleared after some time. The power angle equations are:

Before the fault: $P_{max} \sin\delta = 2.0 \sin\delta$
During the fault: $r_1 P_{max} \sin\delta = 0.5 \sin\delta$
After the fault: $r_2 P_{max} \sin\delta = 1.0 \sin\delta$

Determine the critical clearing angle for the condition described.

(Hint: $\cos\delta_{cr} = \dfrac{(P_m / P_{\max})(\delta_{\max} - \delta_0) + r_2 \cos\delta_{\max} - r_1 \cos\delta_0}{r_2 - r_1}$)

[9 marks]

End of Paper.